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REVIEW PAPER

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2019 Chinese Hypertension League guidelines on home blood pressure monitoring

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Abstract

In China, automated blood pressure monitors have been readily available for home use. Home blood pressure monitoring has been indispensable in the management of hypertension. There is therefore a need to establish guidelines for home blood pressure monitoring on the basis of the 2012 consensus document. In this guidelines

document, the committee put forward recommendations on the selection and calibration of blood pressure measuring devices, the frequency (times) and duration (days) of blood pressure measurement, and the diagnostic threshold of home blood pressure.

1 | INTRODUCTION

In the past 30 years, the management of hypertension has been significantly improved in China. According to the 2012-2015 nationwide blood pressure survey, the prevalence of hypertension (systolic/diastolic blood pressure ≥140/90 mm Hg or use of antihypertensive medication) in Chinese adults of at least 18 years of age was 27.9%.[1] The awareness, treatment, and control of hypertension were 46.9%, 40.7%, and 15.3%, respectively. The treatment rate in those who were aware of their blood pressure was 86.8%, and the control rate in those treated hypertensive patients was 37.6%.[1] If these rates would be compared with that were obtained in the 4th National Nutrition and Health Survey in 2002, the prevalence of hypertension increased by an absolute proportion of +9.1%, while the control rate also increased by an absolute proportion of +9.2%.[2] However, the recent awareness rate in hypertensive patients and the control rate in treated hypertensive patients were all <50%.[1] Apparently, we have to focus on these two major issues. Everybody should measure their blood pressure and be aware whether their blood pressure is elevated and requires drug treatment. Those who have been diagnosed hypertensive may know whether their blood pressure is controlled. Home blood pressure monitoring may play an important role in these aspects.

Along with the improvement in the management of hypertension, home blood pressure monitoring has become widely used.[3] Electronic blood pressure monitors are readily available at home. Home blood pressure monitoring has been an indispensable modality to improve awareness and control of hypertension. However, there are still problems. On the one hand, some technologies that may improve home blood pressure monitoring have not been properly used. In the era of internet, wireless and cloud computing technology, home blood pressure readings are still often recorded, stored, analyzed, and interpreted manually. On the other hand, some other technologies that may have not yet ready for use have been drawn public attention. Cuff-less blood pressure monitors are still in the early development period. However, such devices are almost everywhere in China. Thus, despite that home blood pressure monitors are readily available, home blood pressure monitoring still needs to be standardized, digitized, and intelligent to promote the proper use of home blood pressure monitoring and improve the management of hypertension.

In addition to the 2018 Chinese hypertension guidelines,[4] several recently published national or international guidelines strongly recommend home blood pressure monitoring.[4-6] Several national and international organizations developed specific guidelines or consensus documents on home blood pressure monitoring.[7-12] In 2012, the Chinese Hypertension League published an "expert consensus document on home blood pressure monitoring" in collaboration with several other Chinese organizations of hypertension.[13] In 2018, the HOPE Asia Network published a series of Asian documents to standardize home blood pressure monitoring in the region.[12,14] During the "annual China scientific meetings on blood pressure monitoring" organized by the Chinese Hypertension League since 2015, home blood pressure monitoring has been a major topic. The Chinese experts believe that a specific guideline on home blood pressure monitoring should be developed on the basis of the consensus document in 2012.[13] Home blood pressure monitoring is performed at people's homes. However, the guideline is written still for health professionals in the management of hypertension. It is attempted that this guideline document may help Chinese health professionals use home blood pressure in the management of hypertension and guide hypertensive patients and the public to properly perform home blood pressure monitoring.

2 | WHY HOME BLOOD PRESSURE MONITORING IS USEFUL?

2.1 | To improve awareness of hypertension

Home blood pressure monitoring should not only be used in hypertensive patients. Everybody should regularly measure their blood pressure at home, including those "normotensive" people. A home blood pressure monitor is particularly useful for those "normotensive" people to identify blood pressure elevation, diagnose and treat hypertension and prevent cardiovascular complications. In high-income countries, such as Europe, Japan, and the United States of America, and high-income regions in China, such as Beijing, Guangzhou,[3] and Shanghai,[15] many families have blood pressure monitors at home and the awareness and control rate of hypertension is high.[3,15]

2.2 | To improve diagnostic accuracy of hypertension

Home blood pressure monitoring is performed at people's homes. It may have a greater number of times and days and therefore is a better measure of blood pressure during daily life. Similar to ambulatory blood pressure monitoring, home blood pressure monitoring may identify "white-coat hypertension" or "white-coat uncontrolled

hypertension" with blood pressure elevation only in the clinic, and "masked hypertension" and "masked uncontrolled hypertension" with blood pressure elevation only at home.[16] Thus, it is possible to avoid treating or over-treating "white-coat hypertension" and to treat "masked hypertension."

2.3 | To improve prediction in hypertensive patients

Home blood pressure is superior to clinic blood pressure in cardiovascular prediction. The Ohasama study provided strong evidence in this regard.[17] In this prospective study, 1702 residents living in Ohasama town measured clinic, ambulatory, and home blood pressure. During an average of 11 years' follow-up, 141 cerebrovascular events occurred (137 strokes and four transient ischemic attacks). Home blood pressure, compared with clinic blood pressure, significantly improved prediction of stroke. The risk ratios were significant for a systolic/diastolic blood pressure of ≥115/75 mm Hg at home and ≥160/100 in the clinic.[17]

2.4 | To improve control of hypertension

Home blood pressure monitoring may also improve control of hypertension.[18] Home blood pressure monitoring allows treated hypertensive patients to adjust their antihypertensive treatment, if their blood pressure is not controlled, and ultimately to treat their blood pressure to the target level.

3 | BLOOD PRESSURE MEASUREMENT METHODOLOGY

3.1 | General measurement conditions

If an upper-arm blood pressure monitor is used for home blood pressure measurement, the general conditions are similar to clinic blood pressure measurement. Blood pressure should be measured after 5-minute rest in the seated position on a chair with the back supported. During blood pressure measurement, the arm with cuff should be put on a table and keep the middle of the cuff at the level of heart, with the two legs relaxed on the ground. A more pleasant sitting, such as on a sofa, is also allowed, as long as the middle of the cuff is kept at the heart level.

3.2 | Appropriately sized cuff and bladder

When purchasing a blood pressure monitor, an appropriately sized cuff fitting the main user of the monitor should be requested. For most of the electronic blood pressure monitors, a standard cuff fitting most people (arm circumference <32 cm) and a large cuff (arm circumference ≥32 cm) are usually provided. If used for children, adolescents, or others with slim arms, a small cuff should be chosen.

3.3 | Recording of blood pressure readings

After measurement, if the blood pressure monitor is equipped with an automated data transmission function, the blood pressure readings may be automatically transmitted to a central database in a website or smart phone APP for storage and analysis. Otherwise, the blood pressure readings can also be manually entered in a database in a website or smart phone APP for storage and analysis. If electronic recording is not possible either automatically or manually, the blood pressure readings should be recorded on a notebook for possible clinical use. In this case, name of the person, date and time of measurement, and the values of systolic and diastolic blood pressure, pulse rate, and, if available, mean arterial pressure or pulse pressure should be recorded. Blood pressure monitors with an automated data transmission function have apparent advantages and therefore are preferred.

3.4 | Training for the use of blood pressure monitors

After purchasing, the instructions provided by manufacturer should be carefully learned. If needed, one may seek technical support from health professionals for possible validation or calibration of a blood pressure monitor.

4 | CHOICE OF DEVICES FOR HOME BLOOD PRESSURE MONITORING

4.1 | Validated electronic blood pressure monitors

All electronic blood pressure monitors have to be validated according to a standardized protocol. A universal validation protocol has been recently published by the European Society of Hypertension (ESH), the International Standard Organization (ISO), and the American National Standards Institute, ANSI/Association for the Advancement of Medical Instrumentation (AAMI), that is, the AAMI/ESH/ISO protocol.[19,20] This protocol will hopefully be utilized worldwide via collaboration with regulatory administrations or industry. The validated devices have been listed in the www.stridebp.org website, after scrutiny of a group of experts in the field.

4.2 | Calibration of blood pressure monitors

Blood pressure monitors should be regularly calibrated for accuracy, at least annually. One may seek support from the manufacturer or

health professionals. Some manufacturers do provide calibration service for their customers.

4.3 | Upper-arm automated oscillometric electronic blood pressure monitors

Validated upper-arm devices with oscillometric technique are accurate, reproducible, and ease of use. Such devices have been used in most of clinical studies in hypertension and therefore are preferred.

4.4 | Wrist automated oscillometric electronic blood pressure monitors

Wrist devices have advantages on several conditions, such as low ambient temperature, and people with difficulties in taking off clothes. However, the manufacturers of wrist devices often suggest their specific forearm positions during measurement. The instructions for this matter have to be strictly followed per device. In addition, wrist devices are easy to carry, for instance, during traveling.

4.5 | Finger automated oscillometric electronic blood pressure monitors

Blood pressure measured on a finger is significantly different from that is measured on the upper arm or wrist. It has high variability. Finger devices are not recommended.

4.6 | Auscultatory mercury sphygmomanometry

Auscultation relies on the hearing of the Korotkoff sound phase 1 (start) and phase 5 (stop) for the determination of systolic and diastolic blood pressure. It requires special training. More importantly, mercury is a heavy metal, and a pollutant almost impossible to eliminate from the environment. Such devices are not recommended for home blood pressure monitoring.

4.7 | Auscultatory mercury column-like digital display or aneroid sphygmomanometry

Such devices do not have mercury environmental pollution, but do require training for auscultation. Such devices are also not recommended for home blood pressure monitoring.

4.8 | Various cuff-less devices

Cuff-less devices do not need to inflate and deflate, and improve comfortability. It theoretically allows beat-to-beat blood pressure measurement, and makes real-time continuous blood pressure monitoring possible. That is why engineering scientists are always keen in the development of such cuff-less devices. However, until recently, such technology is still under investigation, needless to say validation of such devices for accuracy in blood pressure measurement. Such devices are therefore not recommended, including non-inflatable wrist and finger APP "blood pressure monitors."

5 | MEASUREMENT FREQUENCY AND DURATION

Home blood pressure measurement is performed at home and is influenced by lifestyle. Taking into account the recommendations of the recent guidelines (Table 1),[7-12,14] lifestyle of the Chinese people, and the results of studies in China,[15,21-23] the recommendations on the frequency and duration of home blood pressure measurement are as follows:

- Blood pressure should be measured 2-3 times consecutively with a 1-minute interval in the morning and evening, respectively, after 5 minutes' rest in the seated position.
- In patients with newly diagnosed hypertension, at the early phase of treatment, or treated but uncontrolled hypertension, blood pressure should be measured for a successive 5-7 days. If blood pressure is well controlled, blood pressure can be measured for at least 1 day per week.
- Blood pressure should be measured after urination. Morning blood pressure should be measured 1 hour after getting up and before drug intake, breakfast, and vigorous exercise, and evening blood pressure after super and before going to bed. Chinese people usually have super early.
- To ensure the quality of home blood pressure monitoring, a diary is needed to record the time of getting up and going to bed, and meals and drug intake.

6 | DIAGNOSTIC THRESHOLDS

The recent major guidelines on home blood pressure monitoring recommended an average home systolic/diastolic blood pressure of ≥135/85 mm Hg as threshold for the diagnosis of hypertension or uncontrolled hypertension.[7-12,14] Some of those guidelines proposed normal limits of home systolic/diastolic blood pressure as <130/80 mm Hg in the European Society of Hypertension guidelines[8,9] and <125/80 mm Hg in the Japanese Society of Hypertension guidelines.[10] The latter also recommended optimal limits as <125/75 mm Hg.

TABLE 1 Frequency and duration of blood pressure measurement for home blood pressure monitoring in various recent guidelines and consensus

Guideline or consensus	Frequency (number of readings on each occasion)	Time of day	Number of days
2008 American Heart Association, American Society of Hypertension Preventive Cardiovascular Nurses Association[7]	2-3 readings with 1-min interval	Morning and evening	Successive 7 d
2008 European Society of Hypertension[8,9]	2 readings with 1- to 2-min interval	Morning and evening before super	Successive at least 3 d and preferably 7 d before clinic visit
2012 Japanese Society of Hypertension[10]	1-3 readings after 1- to 2-min rest in the seated position	Morning and evening after super	Long-term home blood pressure monitoring; at least 5 d per week; if blood pressure is well controlled, at least 3 d per week
2016 Australian[11]	2-3 readings with 1-min interval, after 5-min rest in the seated position,	Same time in the morning and evening before super	Successive 7 d, at least 5 d
2018 HOPE Asia Network[12,14]	At least 2 readings with 1-min interval, after 2-min rest in the seated position	Morning and evening after super	Successive at least 3 d, preferably 7 d

There is no data on normal blood pressure values in the Chinese population. Taking into account the recommendations of various guidelines and consensus,[7-12,14] the current Chinese guideline recommends diagnostic thresholds for home blood pressure as follows:

- If an average home systolic/diastolic blood pressure is ≥135/85 mm Hg, hypertension or uncontrolled hypertension can be diagnosed.
- If an average systolic/diastolic blood pressure is ≥140/90 mm Hg in the clinic but <135/85 mm Hg at home, "white-coat hypertension" or "white-coat uncontrolled hypertension" can be diagnosed.
- If an average systolic/diastolic blood pressure is <140/90 mm Hg in the clinic but ≥135/85 mm Hg at home, "masked hypertension" or "masked uncontrolled hypertension" can be diagnosed.

Home blood pressure monitoring may also be used to evaluate blood pressure in the morning[12,14,24,25] and evening separately,[12,14] and to diagnose morning and evening hypertension or uncontrolled hypertension according to the diagnostic threshold of systolic/diastolic blood pressure ≥135/85 mm Hg.

7 | CONCLUSIONS AND RECOMMENDATIONS

1. In addition to clinic blood pressure measurement and ambulatory blood pressure monitoring, home blood pressure monitoring is recommended for the management of hypertension.
2. Only validated devices are recommended. The upper-arm oscillometric electronic blood pressure monitors are preferred. An appropriately sized cuff should be used.
3. For home blood pressure monitoring, blood pressure should be measured 2-3 times consecutively with a 1-minute interval in the morning and evening, respectively, for a successive 5-7 days at the early phase of treatment. In patients with well-controlled hypertension, blood pressure may be measured for at least 1 day per week. An average of all the blood pressure readings is taken for diagnosis.

Home blood pressure monitoring may significantly improve awareness of hypertension. Thus, family members with "normal" blood pressure should also measure their blood pressure at home at least annually. If home systolic/diastolic blood pressure is in the high normal range, for instance, 130-134/80-84 mm Hg, the number of times should be increased to monthly.

4. Health professionals for the management of hypertension should promote home blood pressure monitoring in treated hypertensive patients as well as normotensive people. They should instruct people in the choice of blood pressure monitors, cuffs, and other accessories and for blood pressure measurement. They should also consider home blood pressure in guiding antihypertensive therapy.

CONFLICT OF INTEREST

JG Wang reports receiving lecture and consulting fees from Bayer, Omron, Pfizer, Salubris, Servier, and Takeda. The other authors declared no conflicts of interest.

AUTHORS' CONTRIBUTIONS

JG Wang prepared the first draft of the manuscript. All members of the writing committee participated in the discussion and revision of

the guidelines and approved the final version and submission of the manuscript.

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